Future Aviation Systems Safety, Phase I

Completed Technology Project (2018 - 2019)

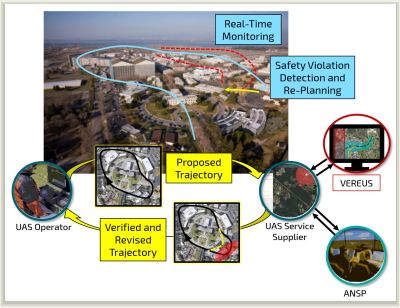
Project Introduction

As Unmanned Aerial Systems (UAS) increase in prevalence within the National Airspace System (NAS), and as their missions grow in scope beyond visual line of sight operations and over populated areas, there is a growing need for automated safety assessment and verification tools to certify that proposed UAS trajectories meet all risk and path constraints imposed quickly and accurately. Verus Research has teamed with Georgia Tech and Penn State on this effort to propose VEREUS, the VErification and RE-planning for Unmanned aerial system Safety tool, which leverages a unified formal methods foundation to verify that multiple forms of risk do not exceed prespecified levels for given UAS trajectories, and to mitigate risks as necessary. The purpose of VEREUS is to automate as much of the trajectory safety verification and necessary re-planning as possible, in as rigorous a manner as possible despite the myriad uncertainties present in UAS Traffic Management (UTM), to decrease the burden on the UAS operator and future UAS Service Suppliers while improving safety, thus significantly increasing the number of UAS that can be managed by a single entity. To achieve this goal, we propose the following tool features: a) offline trajectory assessment to ensure compliance with risk and other Air Navigation Service Provider directed constraints, b) re-planning as required to meet any constraints initially violated, and c) real-time support to ensure continued safety as requirements and trajectories change online. At the end of Phase I, the applicability of formal methods for use in assessing risk to people on the ground, verification of trajectory constraint satisfaction, and re-planning subject to risk constraints will be established, and the building blocks for full development of VEREUS will be in place. VEREUS will ultimately be an integral tool for advancing NASA's UTM efforts, ensuring safe, requirement-satisfying trajectories in an automated fashion.

Anticipated Benefits

VEREUS will provide direct benefits to NASA's UAS Traffic Management (UTM) effort, as a tool used to approve and monitor UAS trajectories. The formal methods components of VEREUS will be available for immediate integration with current NASA UTM risk assessment frameworks. VEREUS can also serve as an interface between operators and the ANSP for all airspace systems that utilize 4D Trajectory Based Operations (TBO), thus aiding NASA's NextGen TBO development and integration efforts.

VEREUS will ultimately transition to the private service suppliers that manage regional UAS operations. Further, both the FAA and the Single European Sky Air Traffic Management Research program are aiming for a future TBO system, and VEREUS will be applicable to their efforts. The military also relies on UAS operations, and must account for safety concerns. VEREUS can thus aid in verifying and enforcing risk constraints for DoD customers as well.



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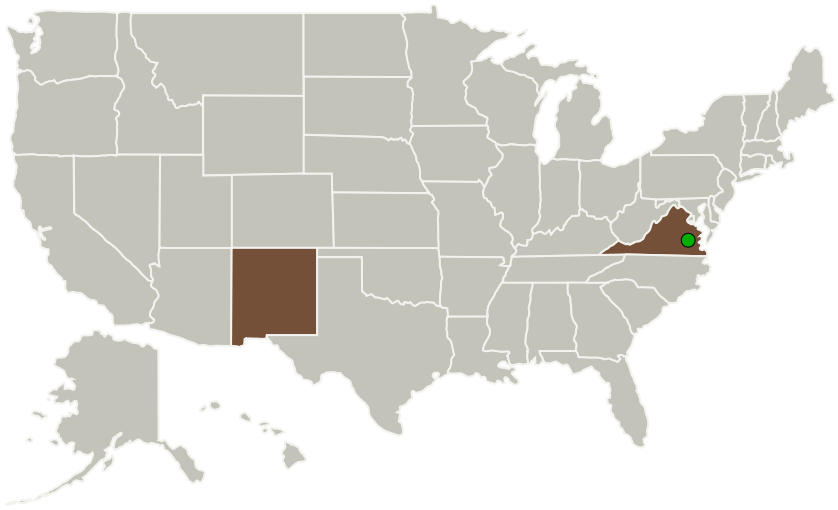
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
XL Scientific, LLC	Lead Organization	Industry	Albuquerque, New Mexico
Langley Research Center(LaRC)	Supporting Organization	NASA Center	Hampton, Virginia

Primary U.S. Work Locations	
New Mexico	Virginia

Project Transitions

July 2018: Project Start

February 2019: Closed out

Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/141349)*

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

XL Scientific, LLC

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

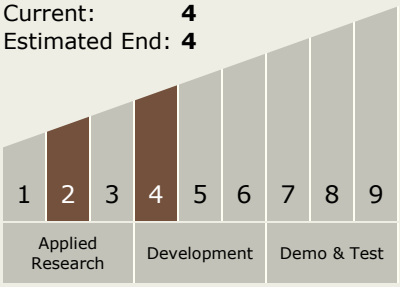
Carlos Torrez

Principal Investigator:

Kendra Lang

Technology Maturity (TRL)

Start: **2**
Current: **4**
Estimated End: **4**



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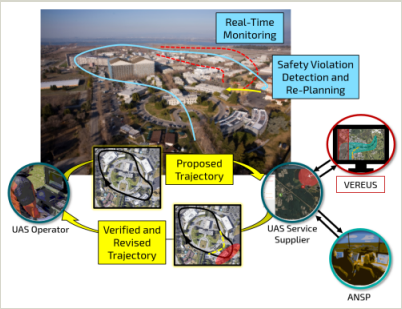
Images



Briefing Chart Image
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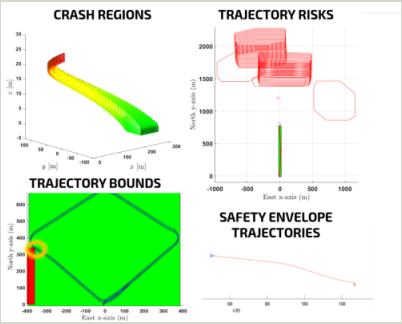
(https://techport.nasa.gov/image/137201)



Final Summary Chart Image
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(https://techport.nasa.gov/image/129229)

Technology Areas

Primary:

- TX01 Propulsion Systems
  - TX01.3 Aero Propulsion
    - TX01.3.1 Integrated Systems and Ancillary Technologies

Target Destination

Earth